Energy Storage – Hydrogen injected into the Gas Grid via electrolysis field test

IGRC, TO5-3
The 18th of September 2014

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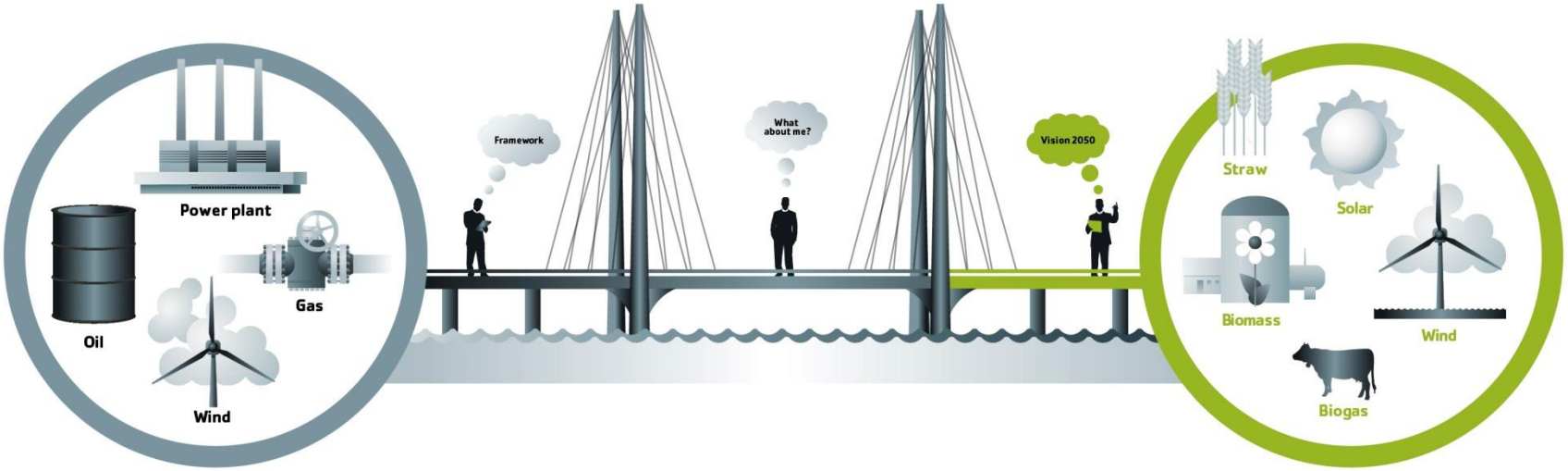
Agenda

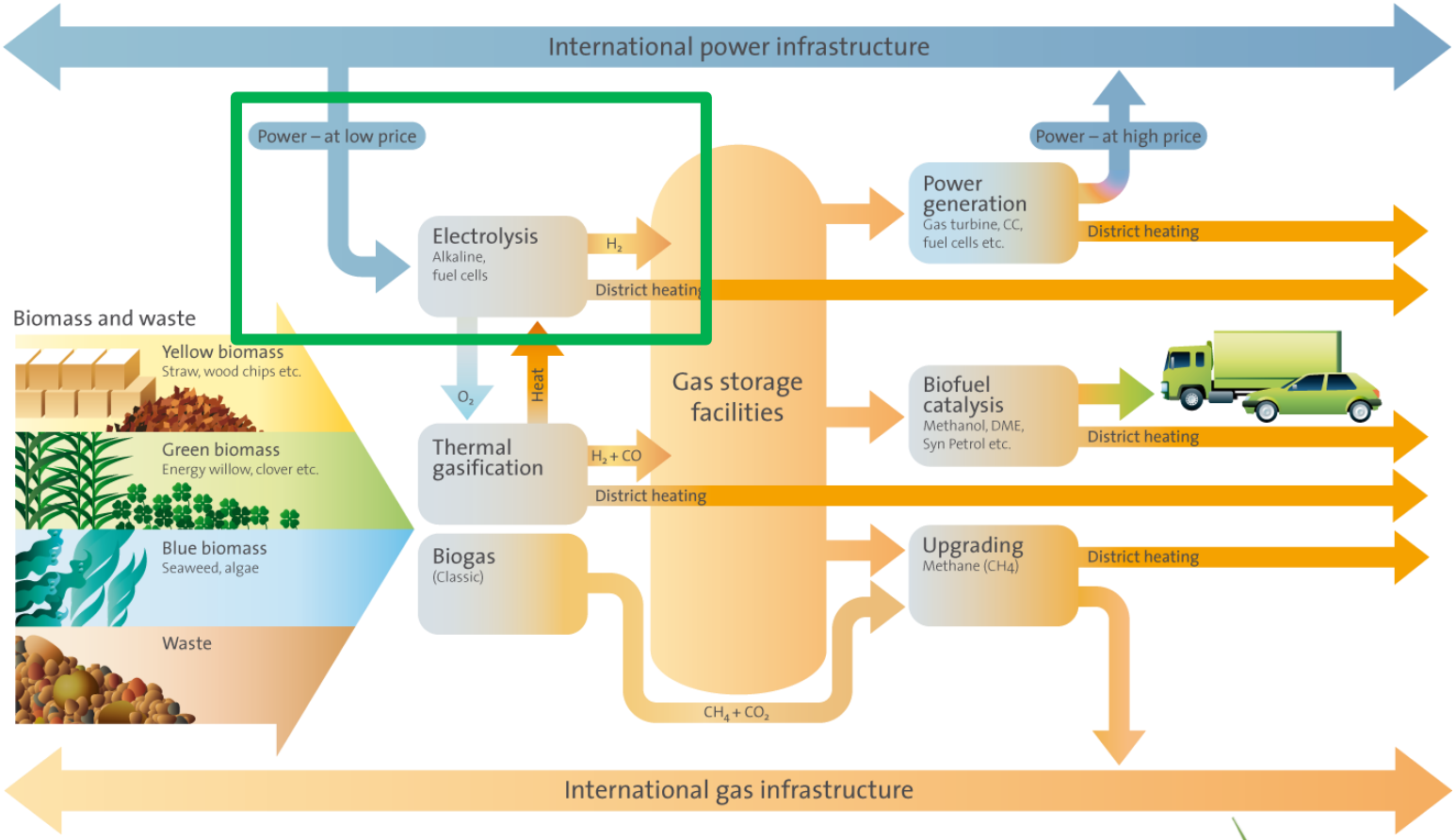
- Background of the project
- Scope
- Technical setup
- Leakage testing
- Summary

Towards a 100 % renewable energy supply

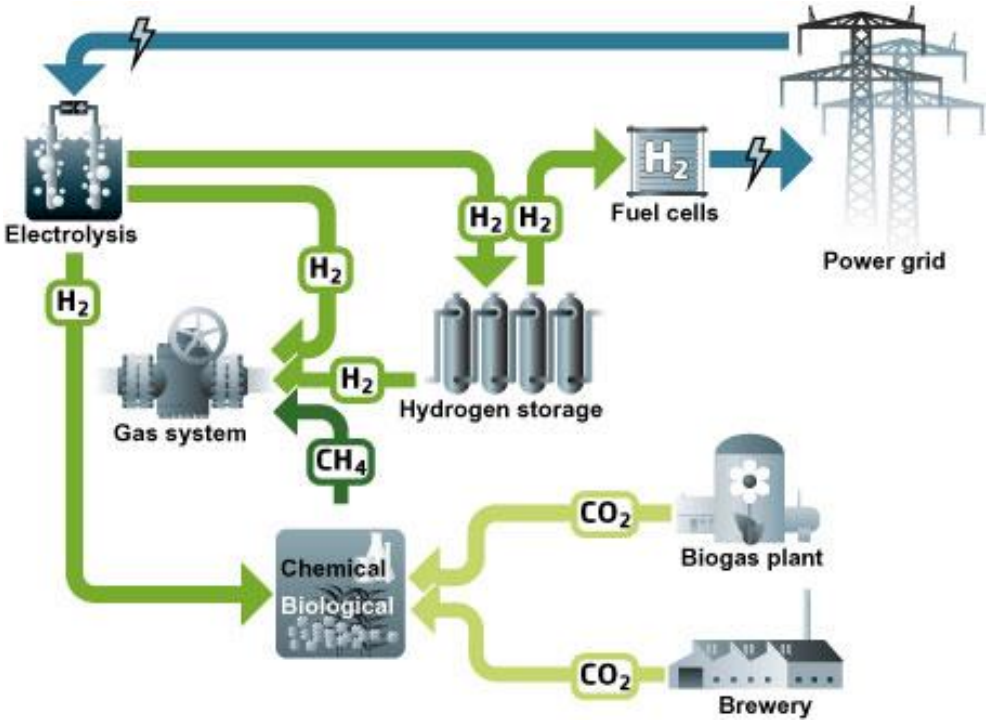


Today → 2050

Integration of energy systems



Hydrogen a part of integrating energy systems



- Hydrogen will be used in different applications:
  - As energy carrier
  - Converted to methane after a reaction with CO2
- Important for the gas system owners to know the limits for hydrogen
- This knowledge is crucial whether the hydrogen is methanized or not.

Properties of hydrogen compared to natural gas

- The energy density of natural gas is about 3 times as big as hydrogen's.
- Hydrogen is 11 times as light as air and 8 times lighter than natural gas.

- The hydrogen molecule is much smaller than a methane molecule
- The explosion limits for hydrogen is much wider than for natural gas
- Hydrogen has a higher probability for self ignition due to a very low energy of ignition compared to methane.

Substance	LEL (%)	UEL (%)	MESG mm	MIC mA	AIT (°C)	TEMP. CODES Temperature Classification
Methane	5	15	1.14	195	595	T1
Propane	2	9.5	0.97	146	470	T1
Ethylene	2.7	34	0.65	108	425	T2
Acetylene	3	17	0.25	60	305	T2
Hydrogen	4	75.6	0.28	75	560	T1

Partners in the project

ENERGINET.DK

IRD
POWERING PEOPLE ANYWHERE

DGC
Danish Gas Technology Centre
- R&D, consulting and measurement services in energy and environment

DONG energy

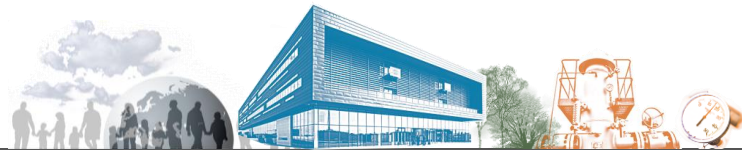
EUDP
Energiteknologisk udvikling og demonstration

Scope of the project

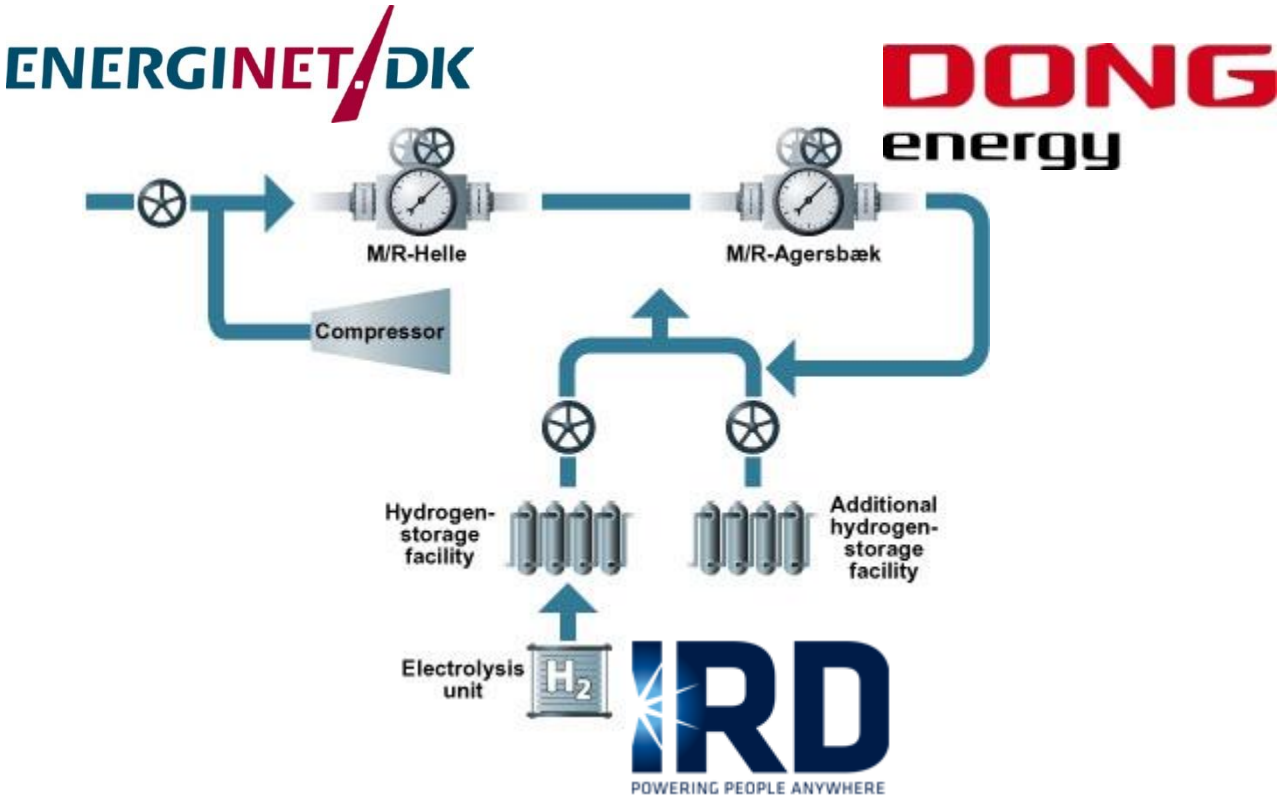
- To acquire knowledge of the solutions and costs of upgrading the gas grid to handle hydrogen admixed in the natural gas
- Important to build up competences in the participating companies

- Test period: 2 years
- Up to 15 % hydrogen
- Hydrogen content will be varied during the test

- Total costs around 1 mill. €
- Funded partly by EUDP: Energy Technology Development and Demonstration Programme



The test loop



Consultant:

DGC

Danish Gas Technology Centre
- R&D, consulting and measurement services in energy and environment

Location of the test site

MR Helle

Facilities

- Redundant natural gas M/R stations
- Both decommissioned because the consumers is now supplied from other branch of the grid
- A 80/40 bar and a 40/4 bar station
- Located as neighbours minimizing the cost to establish the test loop.
- Ideal for the project because they are build and equipped as the rest of the Danish gas system

Expected challenges

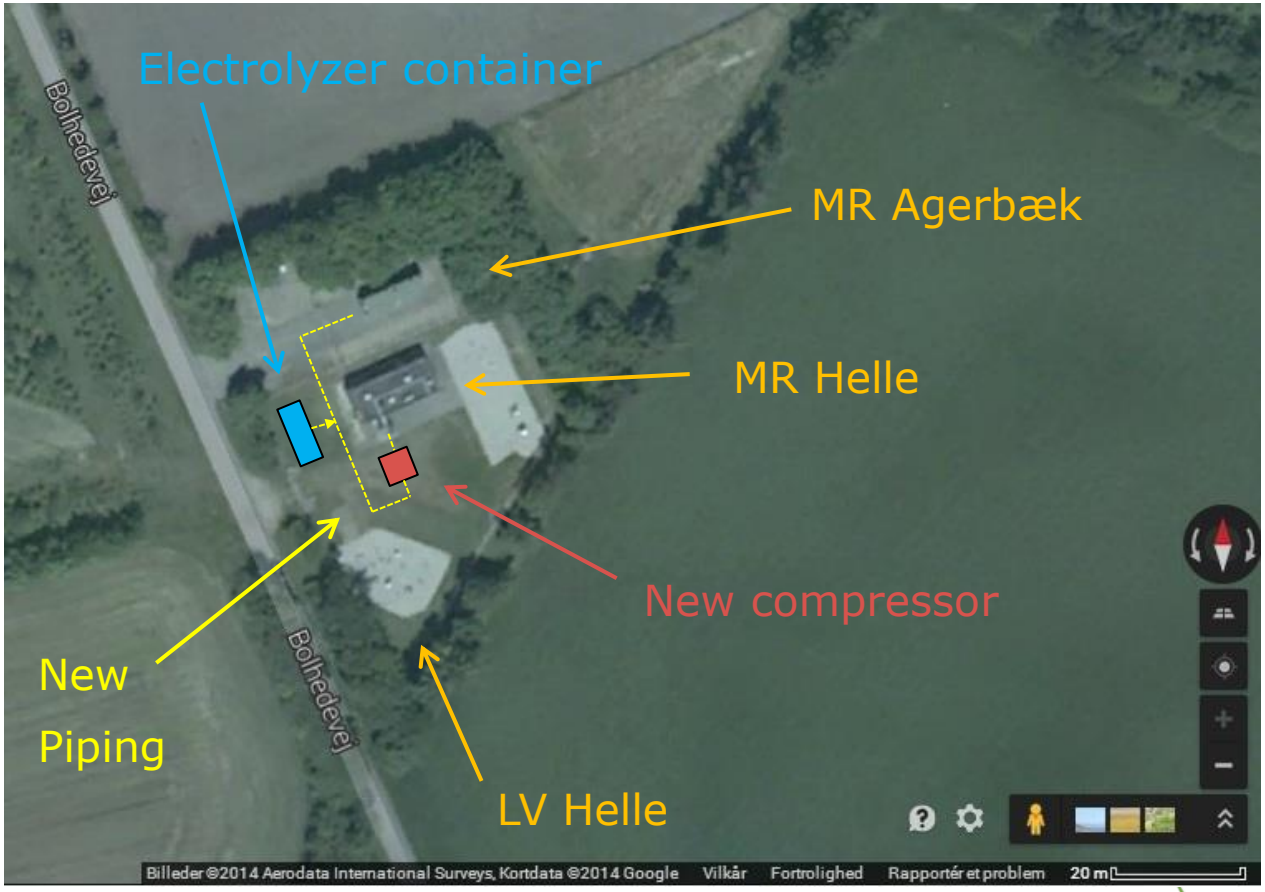
Safety equipment

Seals

Process equipment

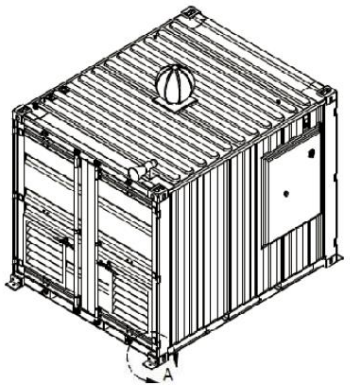
Measurement equipment

MR Helle and MR Agerbæk



Compressor for the test

- Membrane compressor from PDC Machines.
- Build for compression of gas with 100 % hydrogen



The Hydrogen production facility from IRD Fuel Cells

The hydrogen facility is built into a isolated container

μCHP Fuel Cell (Micro **C**ombined **H**eat and **P**ower):

Fuel Cell converts hydrogen to power when the facility is in excess of hydrogen.

Electrolyzer from IRD Fuel Cells:

Converts electrical power to hydrogen by splitting water into hydrogen and oxygen.

Demineralization of water

IRD Electrolyzer – hydrogen production

- Electrolyzer IRD E1050:
- Method: PEM – **P**roton **E**xchange **M**embrane (electrolyte is a polymer membrane)
- Capacity: 1 Nm^3/h (hydrogen)
- Output pressure of hydrogen: 50 bar, 5 MPa
- Hydrogen to be stored in composite cylinder ready to be introduced to the gas net
- Smart Grid ready

Leakage test with forming gas

- Forming gas (90% nitrogen / 10 % hydrogen) was used for the leakage test
- Both M/R stations were pressurized with forming gas to design pressure to find any immediate leakages
- Main pipe, instrumentation and venting facilities was included
- Underground valves was checked via balloons on lubrication pipes and bleeder pipes

Results of leakage test

- The result was surprisingly good!
- Only 11 leakages was found in total
  - 3 flanges with 30 year old seals
  - 5 instrument valves (hydroball valves)
  - A large valve had 2 leakages (solved by renovation)
  - 1 valve at the odorant supply
  - All process equipment passed the leakage test
- The M/R stations are therefore ready for the long term testing with the natural gas hydrogen mixture

Project plan

Year	2014												2015												2016												2017		
Month	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
WP0 - Project management and																																							
WP1 - Preparation																																							
WP2 - Establish the test loop																																							
WP3 - Product maturation of electrolysis plant																																							
WP4 - 24 month test phase																																							
WP5 - Dissemination plan and further work																																							

- Recent activities:
  - Locating potential problems through review of documentation
  - Preparation of process design
  - Leakage test with forming gas
  - HAZID workshop with participation of project group
  - Specification of compressor

Summary

- Project started January 2014
- The 2 year test phase starts March 2015
- A lot of experience will be gained in the building of the test loop

- The project results will be:
  - A practical, public guideline that describes
  - how the M/R stations and gas grid must be adapted to handle the injection of hydrogen in the natural gas grid
  - including consequences for regulatory approvals and operation & maintenance.

Thanks for your attention

- Links for information about the project:
  - http://www.energinet.dk/EN/GAS/Aktuelle-temaer-ny/Udvikling-af-gasteknologier/Brint-i-gasinfrastrukturen/Sider/Brint-i-gasnettet.aspx
  - http://eudp.omega.oitudv.dk/node/7592 (in Danish)

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